NASA SCIENCE MISSION DIRECTORATE

Earth-Sun System Applied Sciences Program
Air Quality Program Element
FY2005-2009 Plan

Version 1.1

March 15, 2005

Expanding and accelerating the realization of economic and societal benefits from Earth-Sun System science, information, and technology

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NASA Science Mission Directorate
Earth-Sun System Division
Applied Sciences Program

Applied Sciences for the Air Quality Program Element

This document contains the Air Quality Program Element Plan for FY 2005-2009. This plan derives from direction established in the NASA Strategic Plan, Earth Science Enterprise and Space Science Enterprise Strategies, Earth Science Applications Plan, and OMB/OSTP guidance on research and development. The plan aligns with and serves the commitments established in the NASA Integrated Budget and Performance Document.

The Program Manager and the Applied Sciences Program leadership have reviewed the plan and agree that the plan appropriately reflects the goals, objectives, and activities for the Program Element to serve the Applied Sciences Program, Earth-Sun System Division, NASA, the administration, and society.

(Signature on file) February 11, 2005
Lawrence Friedl Date
Program Manager, Air Quality
Applied Sciences Program
NASA Earth-Sun System Division

(Signature on file) February 11, 2005
Lawrence Friedl Date
Lead, National Applications
Applied Sciences Program
NASA Earth-Sun System Division

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Director, Applied Sciences Program
NASA Earth-Sun System Division

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NASA Earth-Sun System Division: Applied Sciences Program
Air Quality

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Air Quality Program Element Plan: FY 2005 - 2009

I. Purpose and Scope

This plan articulates the goals and direction of the Air Quality Management Program Element for the period from 2005 to 2009 by detailing the purpose of the program and our strategy to fulfill the air quality mission with the resources available. The plan describes the program's scope, including NASA's role in partnerships, the focus on decision support tools, and the types of Earth-Sun system science results we seek to extend. Within the Earth-Sun System Division, this plan functions as a program management tool, describing the program structure, functional mechanisms, performance measures, and general principles that the Air Quality Management activity will follow. The plan includes projects in which Earth-Sun system science results can be applied to decision making with related socioeconomic benefits.

The Air Quality Management Program Element is one of twelve elements in the NASA Science Mission Directorate Applied Sciences Program. NASA and the Applied Sciences Program collaborate with partner organizations to enable and enhance the application of NASA's Earth-Sun system science results to serve national priority policy and management decision-support tools. The desired outcome is for partner organizations to use project results, such as prototypes and benchmark reports, to enable expanded use of Earth science products and enhance their decision-support capabilities.

The Air Quality Management Program Element extends Earth-Sun science results, products derived from science information, models, technology, and other capabilities into partners' decision support tools for air quality management issues. The Air Quality program addresses issues of concern and decision-making related to air quality planning, compliance, and forecasting. The program focuses on air quality decision tools serving the following classes of issues:

- Air quality planning, assessment, and emission control strategies;
- Air pollution and emissions sources, transport and deposition;
- Emissions inventories;
- Compliance and regulation;
- Air quality forecasting;
- International atmospheric policies and treaties;
- Economic management and trade; and,
- Public and environmental health

NASA partners with Federal agencies and regional-national organizations that have air quality management responsibilities and mandates to support air quality managers – primary partners are the US Environmental Protection Agency (EPA) and the National Oceanic and Atmospheric Administration (NOAA). The program includes participation from international organizations on air quality activities usually through a US partner. Some of the Air Quality program activities relate to other program elements such as Public Health, Aviation, Agricultural Efficiency, Energy Management, and Homeland Security. Air Quality program activities provide results for NASA support to Administration, interagency, and international activities, including the White House Committee on Environment and Natural Resources (CENR), Interagency Working Group on Earth Observations (IWEGO), ad hoc Group on Earth Observations (GEO), Climate Change Science Program (CCSP) and Integrated Global Atmospheric Chemistry Observations (IGACO).

Examples of Earth science missions for the Air Quality program include: Aura, Terra, Aqua, EP-TOMS, CloudSat, CALIPSO, NPP, NPOESS, Glory, and OCO. Examples of Earth science models include: RAQMS, GOCART, MM5, Hysplit, GMAO, WRF-CHEM, and GEOS-CHEM. Project plans associated with the Air Quality program designate specific sensors and models, and they state specific activities with the partners to extend NASA Earth science results (e.g., measurements, environmental data records, geophysical parameters, assimilated data, visualizations, model predictions).

This plan covers objectives, projects, and activities for Fiscal Years 2005-2009. Priority air quality constituents are ozone, aerosols (PM2.5), other EPA criteria pollutants, and emissions indicators (e.g., NO_2, HCHO). In Fiscal Year 2005 (FY05), the program's priority activities focus on completing the transfer of aerosol transport and data fusion techniques to NOAA and EPA for air quality forecasting; validating and benchmarking use of NASA Earth observations from (EP-TOMS, GOES) research spacecraft and data assimilation in Community Multi-scale Air Quality model (CMAQ) boundary conditions; assessing use of satellite observations for fire emissions inventory; incorporating specifications of the physical atmosphere in CMAQ; incorporating specifications of land-use activity modeling in DSTs; evaluating potential support to Weather Research and Forecast model (WRF) and developing activities with NOAA on support to the WRF model/decision tool; identifying international air quality issues to support; pursuing assessment via Observing System Simulation Experiment (OSSE) of CloudSat and CALIPSO observations for forecasting; and pursuing Aura data for contributions to EPA/NOAA forecasts and CMAQ (http://www.wrf-model.org).

In FY06-09, the program's priorities focus on developing prototypes and evolving products for air quality transport and forecasting applications (e.g., aerosols in CMAQ and ozone in forecasts); expanding sources of measurements and model products (e.g. CloudSat, CALIPSO, OCO, NPP, Glory) for air quality; validating and benchmarking Aura products to CMAQ; and, developing products for other air quality decision tools. The program plans to increase its use of competitive solicitations to identify projects.

Scope within NASA and Applied Sciences Program

The Air Quality Program Element is managed in accordance with, and is guided by, the NASA Strategic Plan and Earth Science Enterprise Strategy. The program element benefits from Earth-Sun system science results and capabilities including Operation System Simulation Experiments (OSSEs), Project Columbia, the Joint Center for Satellite Data Assimilation (JCSDA), the Earth-Sun System Gateway (ESG), and the Transition from Research to Operations (R2O). The program element utilizes initiatives such as the Global Information Grid (GIG) and Federal Enterprise Architecture (FEA) and cooperates with national Earth-Sun laboratories and international programs.

The FY05 President's Budget for the NASA Applied Sciences Program* specifies $54M annually for FY05-FY09 for the National Applications ($24M) and Crosscutting Solutions ($30M) activities. While directly managing a subset of the $24M National Applications budget, the Air Quality Program Element (and each of the national applications) benefits from the performance results of the $30M budget for Crosscutting Solutions (see Crosscutting Solutions Program Element Plan). The Air Quality Program Element leverages and extends research results from the approximately $2.1B per year supporting Earth-Sun system science research and development of innovative aerospace science and technology.

Additional information about the NASA Applied Sciences Program can be found at http://science.hq.nasa.gov/earth-sun/applications.

** The National Applications and Crosscutting Solutions components of the Earth Science Applications Theme in the NASA FY05 Integrated Budget & Performance Document*

II. Goals and Objectives

The goal of the Air Quality Management Program is to:

Enable partners' beneficial use of NASA's Earth-Sun science results, observations, models, and technologies to enhance decision support capabilities serving their air quality management and policy responsibilities.

Major tenets of the Air Quality program's goal include:

- Develop and nurture partnerships with appropriate air quality organizations
- Identify and assess partners' air quality management responsibilities, plans, and decision support tools and evaluate capacity of NASA's science results to support the partners' solutions
- Validate and verify application of NASA's science results with partners, including development of products and prototypes to address partners' requirements
- With partners, document value of NASA's science results relative to partners' benchmarks and support adoption to transition from research to operations
- Communicate results and partners' achievements to appropriate air quality communities and stakeholders

In addition, the Air Quality Management program promotes NASA and Earth-Sun System goals and Earth-Sun system science priorities, such as OSSEs, FEA, and Earth-Sun System Gateway, and the program's objectives and activities support and contribute to NASA's goals (e.g., IWGEO, international commitments).

Objectives

The Air Quality Program serves the NASA Strategic Plan Objectives 1.2, 2.2, and 3.1, and the NASA FY05 Integrated Budget and Performance Document (IBPD) Performance Measures 5ESA2, 5ESA4, 5ESA6, 5ESA7, 5ESA8, and 5ESA9 (*ifmp.nasa.gov/codeb/budget2004*).

Specifically, the Air Quality Program Element pursues the following short- and near-term objectives: (Note: Objectives are cumulative totals for the program rather than specific to an individual year.)

Short-term Objectives (FY05)

QI-QII 2005	Complete report on potential NASA science support (e.g., Terra, Aqua, Aura) to at least two major international atmospheric treaties or policies (e.g., stratospheric ozone, international transport of pollutants). Complete report of NASA science capabilities related to NSF WRF, including analysis of potential Earth science product support and candidate measurements and models, such as the Land Use Data Analysis System
QIII - QIV 2005 *5ESA2, 5ESA6, 5ESA7*	Complete transition of MODIS Aerosol Optical Depth (AOD) technique to NOAA & EPA for air quality forecasting. Complete validation & benchmark reports on the transition, improved techniques, and benefits. Validate and complete benchmark report on NASA science support to boundary conditions for CMAQ (e.g., EP-TOMS Ozone residuals, assimilations, and boundary conditions (BC) from RAQMS).

QIII - QIV 2005 (cont.) *5ESA2, 5ESA6, 5ESA7*	Establish agreements with at least one federal partners and at least one non-federal partner or international organization (e.g., Regional Planning Organizations). Complete evaluation report of NASA science capabilities related to specifications of physical atmosphere and land-use associated properties for use in EPA CMAQ. Establish joint development plan with EPA, NOAA on NASA science support (e.g., Terra, Aqua, Aura, CloudSat, RAQMS, GOCART) to air quality tools (e.g., AIRNow AQI, CMAQ, WRF-CHEM), including emissions inventories. Evaluate potential of CALIPSO, CloudSat products to serve AIRNow and CMAQ; utilize Observation System Simulation Experiments (OSSE), as appropriate.

Near-term Objectives (FY06-FY09)

QI-II 2006	Verify and validate NASA science enhancements in at least three separate air quality topics, decision support tools, and policy/management activities. Evaluate potential of NPP products to serve AIRNow and CMAQ and other tools; utilize Observation System Simulation Experiments, as appropriate. Publish at least two articles on NASA science input to air quality decision tools.
QIII-IV 2006	Verify, validate, and complete benchmark report on performance of NASA science products from at least 4 sensors (e.g., Aura, CALIPSO, CloudSat) and models into at least 3 separate air quality decision support tools (e.g., AQI, CMAQ, WRF). Evaluate potential of OCO products to serve AIRNow and CMAQ and other tools; utilize Observation System Simulation Experiments (OSSE), as appropriate. Reports from REASoN (Falke) and EOS (Hutchinson) projects; publications as appropriate.
QI-II 2007	Evaluate application of Glory products to serve AIRNow, CMAQ, and/or other priority air quality decision support tools; utilize Observation System Simulation Experiments, as appropriate.
QIII-IV 2007	Update joint development plans with EPA, NOAA, and other priority partners. Publish at least three articles on air quality applications of Earth science, including at least one in a peer-reviewed journal.
2008	Evaluate application of Aquarius products to serve AIRNow, CMAQ, and/or other priority air quality decision support tools (use OSSEs as appropriate) Verify, validate, and complete benchmark reports on performance of NASA science products from at least 6 sensors on NASA research spacecraft (e.g., OCO, CALIPSO, Glory, NPP) and models into at least 4 separate air quality issues or decision support tools.
2009	Evaluate application of HYDROS and other products to serve priority air quality decision support tools (use OSSEs as appropriate) Publish at least four articles on air quality applications of NASA science, including at least two in peer-reviewed journals. Verify, validate, and complete benchmark reports on performance of NASA science products from at least 7 sensors and models into at least 4 separate air quality issues or decision support tools.

III. Program Management and Partners

Program Management

Air Quality Program Manager: *Lawrence Friedl, NASA-Headquarters*

- Program development, strategy, plans and budgets
- Program representation and advocacy; report results and issues to NASA senior management and beyond
- Manage program to meet IBPD objectives and serve program assessments (e.g., PART)
- Communication of Earth-Sun system priorities and directives to Air Quality program team and network
- Implementation of interagency agreements and partnerships
- Represent program and Applied Sciences Program through interagency/international committees and working groups
- Monitoring Air Quality program measures and performance evaluation

Air Quality Deputy Program Manager: *Doreen Neil, NASA-Langley*

- Leadership and communication to Air Quality program team and network
- Coordination and communication between NASA Centers on Air Quality program activities
- Leadership on project plans, development, performance, and partnership relationships
- Communication of project measures, performance, status, and issues to Program Manager
- Management for grants and cooperative agreements funded through Langley
- Management of Air Quality program tasks at Langley Research Center

Air Quality Network and Partners

The program element maintains a network of organizations and points-of-contact associated with air quality management activities. (Network details maintained in a separate document.)

Earth-Sun System Division and NASA Centers:

Atmospheric Composition Theme	Phil DeCola, NASA HQ
Climate Change and Variability Theme	Don Anderson, NASA HQ
Weather Theme	Tsengdar Lee, NASA HQ
Tropospheric Chemistry and Aerosols	Hal Maring, NASA HQ
Modeling	Don Anderson/Tsengdar Lee, NASA HQ
Technology	Mike Tanner, NASA HQ
Business and Budget	Joan Haas, NASA HQ

Ames Research Center (ARC)	Steve Hipskind
Goddard Space Flight Center (GSFC)	Anne Thompson
Jet Propulsion Laboratory (JPL)	Tony Freeman
Marshall Space Flight Center (MSFC)	Dale Quattrochi/Dick McNider
Langley Research Center (LaRC)	Doreen Neil
Stennis Space Center (SSC)	Troy Frisbie

All Centers can participate with the Air Quality Program. Program management sets direction of the program on several factors, including priorities and discussions with partners, available funding, ideas from Centers, and Center capabilities. This program plan identifies activities in FY05-09 and specifies Centers, based on the program management's understanding of capabilities, partnerships, commitments, etc. Capable centers not referenced or Centers with ideas and partners may approach the program management. The program plans projects/DST's offering and funding through competitive solicitations.

Federal Partners

US EPA .....Jim Szykman (EPA at NASA-LaRC)
Terry Keating (EPA-OAR)

- Office of Air and Radiation (OAR)
- Office of Air Quality Planning and Standards (OAR-OAQPS)
- Office of Environmental Information (OEI)
- Office of Research and Development (ORD)

NOAA .....Jim Maegher, Pai-Yei Whung
Shoba Kondragunda, Steve Fine

- Air Resources Lab (ARL)
- Aeronomy Lab (AL)
- National Weather Service (NWS)
- National Environmental Satellite, Data and Information Service (NESDIS)
- National Center for Environmental Prediction (NCEP)

Federal Aviation Administration (FAA).....Julie Draper

Agriculture Department (USDA) .....Ray Knighton, Al Ribeau

- US Forest Service (USFS)

Regional Planning Organizations

CENRAP: Central Regional Air Planning Association
MANE-VU: Mid-Atlantic/Northeast Visibility Union
Midwest RPO: Midwest Regional Planning Organization
VISTA: Visibility Improvement State and Tribal Association of the Southeast
WRAP: Western Regional Air Partnership

International, National and Regional Organizations

NARSTO (formerly North American Research Strategy for Tropospheric Ozone)
IGOS: Integrated Global Observing Strategy (IGACO – Atmospheric Composition Theme)
ECOS: Environmental Council of the States
Washington University at St. Louis – NASA Cooperative Agreement
University of Texas-Austin – NASA Cooperative Agreement
A&WMA: Air & Waste Management Association

Distributed Active Archive Centers (DAAC) and Earth Science Modeling Centers:

Langley Atmospheric Sciences DAAC (LaRC DAAC - LaRC)
GSFC Earth Science DAAC (GES DAAC - GSFC)
Land Processes DAAC (LP DAAC - USGS)
National Space Science and Technology Center (MSFC)

CIMSS: Cooperative Institute of Meteorological Satellite Studies
NCAR: National Center for Atmospheric Research
AeroCenter: GSFC Center for Aerosol Research
GISS: Goddard Institute for Space Studies

IV. Decision Support Tools and Air Quality Issues

Priority Decision Support Tools: FY05-06

AIRNow and Air Quality Index

EPA provides a data clearinghouse, central forecast facility, and archive for regionally and locally generated daily air quality forecasts under its AIRNow Program, which developed the AQI as a health-based index for reporting air quality. AIRNow gathers data from numerous sources, including a nation-wide network of *in situ* monitors. EPA has regularly reported AQI for ozone, and initiated a PM AQI in October 2003. EPA has an AQI for five major air pollutants: ground-level ozone, PM, carbon monoxide, sulfur dioxide, and nitrogen dioxide. EPA, state and local agencies, and the media report current and forecast AQI and air quality conditions. NASA works with EPA and NOAA to evaluate, validate and verify, and benchmark this assimilation of MODIS AOD, MODIS Cloud Optical Thickness (COT), wind speeds, air trajectory models, and data fusion techniques to assist the products they provide to air quality forecasters and the public (www.epa.gov/airnow).

Community Multi-scale Air Quality Model

EPA, with assistance from NOAA and the modeling community, developed the Community Multi-scale Air Quality model (CMAQ/Models-3), to improve the environmental management community's ability to evaluate the impact of management practices for multiple pollutants and multiple scales and to improve the scientist's ability to understand and simulate chemical and physical interactions in the atmosphere. CMAQ is a comprehensive air quality modeling system, and CMAQ simulates processes to describe the generation, fate, and transport of atmospheric pollutants and urban, regional, and national air quality over several time scales. EPA, States and Regional Planning Offices (RPO) use CMAQ to simulate effects of pollution control options, assess multi-pollutant impacts, track and predict changes in emissions mitigation strategies, develop implementation plans, and make regulatory decisions. NASA works with EPA on use of EP-TOMS, Aura, and observations from other research spacecraft as well as Global-to-Regional models (GOCART, RAQMS) to develop regional boundary conditions to initialize CMAQ, especially for ozone, particulate matter, physical parameters, and landscape characteristics. CMAQ is also the basis for work on air quality forecasting activities (www.epa.gov/asmdnerl/models3).

NOAA Forecasting

NOAA, in cooperation with EPA, began providing operational, daily air quality forecasting in September 2004. Initial guidance focuses on 1-2 day ozone forecasts for the Northeastern U.S. NOAA plans to expand the coverage incrementally to cover the entire nation by 2008. In addition, NOAA plans to include PM forecasts within five years, and, within the decade, NOAA plans to add additional pollutants and extend forecast intervals to two days or beyond. The initial operational modeling system, to be run at NOAA's NCEP, will consist of NOAA's Eta meteorological model linked with EPA's CMAQ model. The coupled Eta-CMAQ system will initially produce forecasts with a grid resolution of 12 km. Major issues related to air quality forecasting include emissions sources, transport/dispersion, and weather. Key NOAA activities to improve ozone forecasting include reducing land-use error, temperature interpolation error, and boundary conditions (http://www.nws.noaa.gov/ost/air_quality/).

Emissions Inventories

Emissions inventories cut across several aspects of the Air Quality program. EPA prepares a national database of air emissions information (a.k.a., emissions inventory) with input from numerous State and local air quality monitoring/reporting agencies. These data are used for air dispersion modeling, regional strategy development, regulation setting, air toxics risk assessment,

and tracking trends in emissions over time. The EPA emissions inventory contains CO, NOx, SO_2, PM, VOCs, and NH_3. The inventory defines the pollutant sources as point, area, or mobile. The NASA Air Quality program works with partners on appropriate priorities and activities related to emissions inventories, such as emissions from wildfires or measurable natural and anthropogenic (HCHO, NO2) sources or proxies (*www.epa.gov/ttn/chief/net/index.html*).

Weather Research and Forecasting - Chemistry (WRF-Chem)

WRF is a next-generation meteorological model being developed collaboratively among several agencies (NOAA/NCEP, NOAA/FSL, NCAR). WRF-Chem is a version of WRF that simulates trace gases and aerosols simultaneously with meteorological fields in the WRF framework. WRF-Chem model will have the option to simulate the coupling between dynamics, radiation and chemistry. Uses include forecasting chemical-weather, testing air pollution abatement strategies, planning and forecasting for field campaigns, analyzing measurements from field campaigns and the assimilation of satellite and *in-situ* chemical measurements (*www.wrf-model.org*).

Potential Air Quality Management Issues: FY05-09

On an on-going basis, the Air Quality team consults with partners to identify important issues facing the air quality community, examines associated decision support tools, and determines priorities within the Air Quality program portfolio. Topics include:

- Long-range air pollution transport
- International atmospheric treaties
- Land-characteristics and heat flux in air quality models
- Aviation-related pollution (airborne and ground)
- Visibility and regional haze

To date, the program has focused largely on atmospheric chemistry and aerosols. In FY05-09, the program plans to increase extension activities related to physical meteorology and land-cover characteristics as potential Earth science products to extend to air quality forecasting and planning.

Roadmap and Integrated System Solutions Diagram

Appendix A illustrates a candidate configuration for the extension of NASA science measurements, model products, and data fusion techniques to support Air Quality partners, their decision support tools, and benefits of Earth science to society.

Appendix B includes a roadmap of activities within the Air Quality Management program related to support of air quality policy and management decision support tools.

Cross-Application Activities

The Air Quality Management team coordinates and evaluates activities jointly with other Applied Sciences Program Elements on related topics and decision support tools. Related topics include:

Connection with Public Health: Air Quality Forecasts - AIRNow & Air Quality Index

The Public Health program works with EPA and the Centers for Disease Control and Prevention (CDC) on the public health dimensions of air quality issues. The Air Quality and Public Health teams coordinate efforts to capitalize on the potential benefits of the Applied Sciences results to multiple partners such as the Environmental Public Health Tracking Network (EPHTN)

Connection with Disaster Management: Emissions Inventories
The Air Quality program and the Disaster Management program coordinate on activities related to wildfires and the associated smoke and PM emissions from wildfires. One model that will be assessed is the BlueSkyRAINS for use with Agricultural and Forest Slash Burns through out the Pacific Northwest.

Connection with Aviation: Airport Pollution Dispersion
In FY04, the Air Quality application and the Aviation application jointly sponsored a report on the identification and evaluation of FAA decision tools and potential Earth science results to extend. The Federal Aviation Administration (FAA), EPA, US Civil Aviation Environmental Program (CAEP), and the International Civil Aviation Organization (ICAO) help airports address air pollution compliance issues (EPA and FAA are part of CAEP). Major issues of concern include NOx, PM from smoke, CO, and unburned hydrocarbons as well as local airport meteorology, which can direct pollutants toward local communities. The FAA has developed and employs air dispersion models to examine the spread and track air pollution around airports. Air Quality and Aviation expect to seek proposals related to aviation air quality issues in current and upcoming solicitations from agencies such as the National Academy of Sciences (NAS). Note: In FY04, EPA indicated limited interested at current time in pursuing activities related to urban heat islands. EPA highlighted a need for broader activities related to land-use/cover and associated properties in models (beyond urban areas). The program expects to pursue these activities in projects and solicitations.

V. Application Activities

The Air Quality application sponsors several activities to achieve the goal and objectives of the program. The descriptions below provide a brief introduction to a project or activity, including Project/Studies Managers, suggested Centers involvement, budget, etc. It is implicit that the activities include interaction and relationship development with partners (technical and programmatic) in order to jointly define useful products, to build support and sponsorship, and to develop technical level experts and prototypes.

Beginning in FY05, the Air Quality program expects to increase the amount of projects identified and sponsored through competitive solicitations. The program will continue to support peer-reviewed, directed projects for activities that partners identify as high priority and where timing is critical – in these cases, the project plans will undergo a peer review process to ensure high quality. However, the program expects 1) to reduce the number of these and 2) to begin to transition some activities to competitive solicitations. For example, the program expects to fund MODIS aerosol forecasting work directly through FY05 and use competitive solicitations to support future improvements to aerosol forecasting activities.

Program management expects project plans be developed and managed with input and suggestions from all relevant Centers and organizations -- both the Centers and project managers bear responsibility to contribute, review, and improve project plans. Within projects, budget and responsibility must be allocated to Centers and other organizations relative to the purpose and need of the projects – equal distributions are unexpected.

A. Projects

The Air Quality program element authorizes peer-reviewed projects to support the program's goal and objectives. The respective project teams are responsible for developing project plans and managing the activities. The Project Plans should specify the Earth-Sun science observations, models, and other outputs to extend to decision support tools as well as the activities to produce appropriate deliverables; the plans should integrate contributions from appropriate Centers and rarely will be specific to one Center.

Projects will likely use observations from sensors on: Aura, Terra, Aqua, EP-TOMS, CloudSat, CALIPSO, NPP, NPOESS, Glory (APS), and OCO. FY05 budget figures presented are for procurement dollars; FY06 and beyond figures are full cost.

Project: Air Quality Planning (Chemical, Aerosols)

The goal of this project is to evaluate, validate and benchmark role of Earth science products, spacecraft measurements, and assimilation products for beneficial, routine use in air quality planning tools, specifically CMAQ.

FY05 – Chemical: Continue work on examining ozone boundary conditions for CMAQ – proof of concept with historical ozone data based on TOMS-EP and GOES approaches. Prototype/validate activities with EPA on time-varying boundary conditions. Goal: Benchmark activities for transition in FY06+. Evaluate AIRS CO ground/observational spacecraft comparisons (based on Research and Analysis Program-funded **Algorithm Theoretical Basis Document** ATBD) and begin assimilation into CMAQ.

Aerosols: Initiate evaluation/approaches for aerosols (observational spacecraft measurements, assimilations, boundary conditions).

FY06-beyond: Transition successful efforts and techniques on time-varying boundary conditions to EPA and CMAQ. Evolve BC support through Aura, other measurements, and assimilations. Evaluate OMI satellite-surface comparisons and pursue prototypes as appropriate. Combine physical products with chemistry products and include/extend land-surface characteristics to models as appropriate. Evolve and transition aerosol techniques.

Budget ($K)

Procurement

FY05	375
FY06	375
FY07	300
FY08	300
FY09	--

Project Manager	*Centers*	*Timeframe*	*Partners*
Doreen Neil-LaRC	LaRC, GSFC, MSFC, JPL	FY04-FY08	EPA, NOAA

Earth Science Products	EP-TOMS, GOES, Aura (OMI-HRDLS-TES), GOCART, RAQMS, GMAO, GMI, MODIS
Deliverables	Contact network, evaluation report(s), validation report(s), joint development plan, benchmark report(s), results conference(s) Workshop for consensus on approach to aerosols in CMAQ Prototype solutions based on OSSE

Other Apps.

N/A

Note: This project draws on significant coordination between LaRC, GSFC, and MSFC on chemical, physical, land measurements and assimilations. The project plan specifies groups within each center for support and coordination.

The program expects to solicit proposals for some to all of the activities through competitive solicitations.

Project: Air Quality Planning (Physical, Land-Air Connections)

The goal of this project is to evaluate/validate the role of Earth-Sun science physical parameters and land-characteristics products that can serve as input to CMAQ. The project focuses on physical meteorology, land characteristics, land-atmosphere exchange, and ammonia emissions and on developing and validating Earth science products for routine use in air quality decisions. Possible benchmark in future.

Physical/Land: Complete evaluation report on incorporation of specification of physical atmosphere and land-use & associated properties into CMAQ. Assess improvements to CMAQ based on physical atmosphere and land-use properties. Pursue joint plans with EPA if improvements are worthwhile.

Land Atmosphere/Ammonia: Integrate model products with EPA CMAQ (FY04-06: ~85K); benchmark report.

Budget ($K)	*Procurement*
FY05	150
FY06	200
FY07	200
FY08	170
FY09	--

Project Manager	*Centers*	*Timeframe*	*Partners*
Christa Peters-Lidard, GSFC Dale Quattrochi & Dick McNider, MSFC	GSFC, MSFC, LaRC	FY04-FY06	EPA

		Other Apps.
Earth Science Products	Land Surface Model, Ammonia Model	
Deliverables	Contact network, validation report(s)	Ag. Effic.

Note: This project draws on significant coordination between GSFC, MSFC, and LaRC. The project plan specifies groups within each center for support and coordination.

The program expects to solicit proposals for some to all of the activities through competitive solicitations.

Project: Air Quality Forecasting

The goal is to develop, validate and benchmark NASA science products, especially observational spacecraft products and data fusion and models, for beneficial, routine use in EPA AIRNow-AQI and EPA-NOAA air quality forecasts.

FY05 Aerosols: Complete transition of techniques to NOAA/EPA through CIMSS, including activities to get NOAA approval. Update validation/benchmark report based on system improvements and forecasts. Complete flags for snow mask and reflectivity in desert SW for operational support.

Ozone: Comparisons with ground data (TOMS); evaluation of Aura / OMI & comparisons with ground. Pursue activities with EPA AIRNow AQI; set plan with NOAA WRF.

Other: Evaluate potential for Earth science results to support EPA advisory on NOx, SOx, HCHO (based on AIRNow plans/direction)

FY06-9 Aerosols: Use solicitations to support enhancements, such as vertical insights and/or urban-specific products based on user need.

Ozone: Develop prototype for ozone to NOAA WRF. Benchmark results and transition techniques to NOAA.

Budget ($K)

Procurement

FY05	180
FY06	180
FY07	180
FY08	200
FY09	200

Project Managers	*Centers*	*Timeframe*	*Partners*
Doreen Neil-LaRC Lorraine Remer and Anne Thompson-GSFC	LaRC, GSFC	FY04-FY08	EPA, NOAA

Earth Science Products	Terra – MODIS, Aqua – MODIS, CloudSat, CALIPSO
Deliverables	Prototype products delivered to forecasters network, agreement & joint development plan, benchmark report(s), results conference(s)

Other Apps.

Pub. Health

Note: This project requires very strong links between GSFC and LaRC to develop aerosol products, prototypes, and support transfer to EPA as well as strong coordination on technical and programmatic issues, including aerosol measurements, visualizations, and partner coordination.

The project plan identifies groups within each Center for support and coordination.

The program expects to solicit proposals for some to all of the activities through competitive solicitations.

Project Emissions

The goal of this project is to evaluate, validate and benchmark role of NASA science products, observational spacecraft measurements, and assimilation products to support emissions inventories, factors, etc. that serve air quality planning, assessments, forecasting, etc.

The project is a combination of activities: activities with the RPO WRAP to support regional haze, activities with BlueSkyRAINS, and on-going efforts to support emissions inventories more timely.

FY05: Project with RPO WRAP to examine Earth science products to support modeling for 2002 regional haze responsibilities. Evaluate/validate/benchmark role of Earth science products to capture fires and emissions - compare observed to reported fire databases. Prototype technique to extend to emission inventory.

Activities to support the interagency BlueSkyRAINS test in Summer 2005, including evaluation of Earth science products to support BlueSkyRAINS and development of integration plan.

FY06-07: Develop prototype for on-going use of Earth science results for emissions inventories. Transition technique to partners.

Budget ($K)

Procurement

FY05	180
FY06	180
FY07	180
FY08	200
FY09	200

Project Manager	*Centers*	*Timeframe*	*Partners*
Amber Soja – LaRC TBD – GSFC	GSFC, LaRC	FY04-FY06	RPO–WRAP EPA, USDA

Earth Science Products	Terra-MODIS, MOPITT; Aqua-MODIS; CALIPSO
Deliverables	Validation report, benchmark report(s), results conference(s)

Other Apps.

Disast. Mgnt,
Ag. Effic.

Note: This project draws on significant coordination between LaRC and GSFC. The project plan specifies groups within each center for support and coordination.

The program expects to solicit proposals for some to all of the activities through competitive solicitations.

B. Solicitations

The Air Quality program selects projects through competitive solicitations to serve the program's goal and objectives. For proposals selected through solicitations funded by the Applied Sciences Program, the Air Quality program element may provide supplemental funding. In addition, the Air Quality program may provide funds to projects identified through other NASA solicitations if the projects have specific ties to the program's objectives. The Air Quality team facilitates appropriate partnerships between selected investigators and the Air Quality application's partners.

REASoN: Particulate Air Quality Management

This activity partners with EPA, RPOs, and state organizations to develop a Federated PM network and associated tools to produce NASA science aerosol products to the Air Quality community, especially Web-tools to support decision making through data access, visualization, and analysis.

Budget ($K) (Funding from REASoN)

FY05	284
FY06	312
FY07	320
FY08	334
FY09	--

Studies Manager	*Prin. Investigator*	*Timeframe*	*Partners*
Doreen Neil – LaRC	Stefan Falke – Wash. Univ. in St. Louis	FY04-FY08	EPA, RPOs, States

Earth Science Products	Terra – MODIS, Aqua - MODIS
Deliverables	Project plan, semi-annual reports, results conference

Associated Apps.

Pub Hlth., Ag Effic.

Emissions Inventories (Supplement to RSP Solicitation)

The purpose of this activity is to examine the ability of satellite-based measurements and models to develop emission inventories for use by air quality models and managers.

This activity is a cost-share between Research and Analysis and Applied Sciences (combined $150K per year for 3 years)

Budget ($K) (AQ Funding)

FY05	50
FY06	50
FY07	--
FY08	--
FY09	--

Studies Manager	*Prin. Investigator*	*Timeframe*	*Partners*
Jim Gleason – HQ & GSFC	Randall Martin – Harvard Univ.	FY04-FY06	EPA

Earth Science Products	EP-TOMS, OMI, HRDLS, GEOS-CHEM, MM5, RAQMS
Deliverables	Project plan, semi-annual reports, results conference

Other Apps.

Ag. Effic.

EOS Follow-on: EOS Products for Air Quality Management

The purpose of this activity is to evaluate the use of EOS products for monitoring and modeling air quality in Texas, including transport & generation. Project focuses on aerosol and cloud data products for air quality management.

Project began in FY04 ($295K)

Budget ($K) (EOS Funding)

FY05	293
FY06	279
FY07	--
FY08	--
FY09	--

Studies Manager	*Prin. Investigator*	*Timeframe*	*Partners*
Lawrence Friedl – HQ	Keith Hutchinson – U.Texas Austin	FY04-FY06	Texas CEQ

Earth Science Products	MODIS, MISR, AMSR-E, HSB
Deliverables	Requirements, algorithm, forecast model assessment, report

Other Apps.

N/A

C. Congressionally Directed Activities and NASA Challenge Grants

The Air Quality Management program manages congressionally directed activities and NASA Challenge Grants associated with the application. The Air Quality team interacts with the recipients to align their activities with the goals and objectives of the Applied Sciences Program and the Air Quality Program Element.

There were no FY04 congressionally directed activities or NASA Challenge Grants for Air Quality and none expected in FY05.

D. Project Management

The Air Quality Management program element authorizes activities that contribute to the overall success of the program through studies, working group participation, program reviews, and similar enabling endeavors.

<table>
<tr><th colspan="5">Project Management: Decision Support Tools, Partner Plans, Working Groups, Committees</th></tr>
<tr><td colspan="4">• Identify & evaluate AQ management issues & decision support tools for future support (e.g., EPA Visibility and regional haze)
• Support interagency, national, regional, and international working groups (e.g., CCTP, IGOS, IGACO, NARSTO)
• Evaluation reports</td><td>Budget ($K)
FY05 60
FY06 100
FY07 100
FY08 100
FY09 100</td></tr>
<tr><td>PS Managers</td><td>Centers</td><td>Timeframe</td><td>Partners</td><td></td></tr>
<tr><td>D. Neil – LaRC</td><td>LaRC, GSFC, SSC, ARC, MSFC, JPL</td><td>Annual</td><td>EPA</td><td></td></tr>
<tr><td>Earth Science Products</td><td colspan="3">EP-TOMS, OMI, HRDLS, GEOS-CHEM, MM5, RAQMS, GOCART</td><td>Other Apps.</td></tr>
<tr><td>Deliverables</td><td colspan="3">Meeting reports; Evaluation reports on issues and decision support tools; Analyses and/or Recommendations; Annotated bibliographies; References in Project Evaluation reports</td><td>N / A</td></tr>
</table>

<table>
<tr><th colspan="4">Project Study: Air Quality and Atmospheric Treaties</th></tr>
<tr><td colspan="4">Examine international atmospheric policies and treaties and the potential role NASA science results may play in the policy making and decision support. This project identifies the policies/treaties, their schedules, and major issues and decisions facing the organizations. The information and analysis should identify possible policy-directed applications of NASA science on international fronts and partnerships.</td><td>Budget ($K)

(50K in FY04)
FY05 --
FY06 --
FY07 --
FY08 --
FY09 --</td></tr>
<tr><td>PS Manager</td><td>Centers</td><td>Timeframe</td><td>Partners</td><td rowspan="2">Other Apps.

N / A</td></tr>
<tr><td>L. Friedl - HQ</td><td>GSFC, LaRC</td><td>FY04 – FY05</td><td>EPA</td></tr>
<tr><td>Earth-Sun Science Products</td><td colspan="3">Report to identify appropriate Earth science observations, models</td></tr>
<tr><td>Deliverables</td><td colspan="3">Analysis report; Annotated bibliography; Schedule and recommendations</td></tr>
</table>

E. Additional Activities and Linkages

NASA Applied Sciences Research and Education Activities

The Air Quality Management program element draws on activities supported by the NASA Earth Science Research community and NASA Earth Science Education programs that may have potential or specific applications to the program element's goal and objectives. The Air Quality program monitors the activities for potential support. See Appendix D.

Crosscutting Solutions

The Air Quality Management Program leverages, utilizes, and contributes to priority activities within the Applied Sciences Program, such as the following: Geoscience Standards and Interoperability, Human Capital Development, Integrated Benchmark Systems, and Solutions Networks. Examples of leveraged activities are:

- *Earth-Sun System Gateway* is a "portal of portals" providing an access point through an Internet interface to all web-enabled NASA research results
- *A Rapid Prototyping Center* is a proposed center at Stennis to support NASA and partners in testing and verification of Earth science results in decision support tools.
- *Transition from Research to Operations Network (R2O)* is a network that focuses on systematically transitioning the results of research to operational uses.
- *DEVELOP* is a student-based program for rapidly prototyping solutions for state and local applications and helping students develop capabilities related to applied Earth-Sun science.

NASA and Science Mission Directorate Priorities

The Air Quality Management Program leverages, utilizes, and contributes to priority activities of NASA and the Federal Government, including:

- *Federal Enterprise Architecture (FEA)* is a business and performance-based framework to support cross-agency collaboration, transformation, and government-wide improvement.

- *The Global Information Grid (GIG)* is the first stage of a U.S. military global, high-bandwidth, internet protocol-based communications network (a.k.a., 'internet in space').
- *The Joint Center for Satellite Data Assimilation (JCSDA)* is a multi-agency collaboration to accelerate and improve the quantitative use of research and operational observational spacecraft data in weather and climate prediction models. NOAA (NESDIS, NWS, OAR), NASA, Navy, Air Force, and NSF (through UCAR) collaborate in JCSDA.
- *Metis* is a visual modeling software tool for planning, developing, and analyzing agencies' enterprise architectures. The Applied Sciences Program is using Metis to identify possible linkages between observations, models, and decision support tools to support the IWGEO and NASA/NOAA R2O activities.
- *Observing System Simulation Experiments (OSSEs)* use simulated observations to assess the impacts of future observational spacecraft instruments on weather and climate prediction, and OSSEs provide opportunities to test new designs and methodologies for data-gathering and assimilation.
- *Project Columbia* is a NASA-wide project to develop a new, fast supercomputer (using an integrated cluster of interconnected processor systems) to support the Agency's mission and science goals, including enhanced predictions of weather, climate, and natural hazards.

VI. Budget: FY05-09

The following table lists the Air Quality Program budget (procurement) for FY2005:

Air Quality	
Project	**FY05 Procurement Allocation ($K)**
Air Quality Planning: CMAQ chemical (BCs)	$375
Air Quality Planning: CMAQ and land, physical, aerosols	$150
Air Quality Forecasting - NOAA CMAQ & WRF	$180
Air Quality - Emissions: WRAP RPO; land characteristics	$180
Emissions Inventories	$50
Prog. Mngt: Working Groups & Reports	$60
Total	$995

Appendix C lists program-wide budget allocations for FY2005-09.

VII. Schedule and Milestones

Air Quality Management Application -- FY05-09 Schedule

	Activity	Start	FY05	FY06	FY07	FY08	FY09	Comments
AQ Planning	Ozone BC	FY04	>					Bench in 05; transit. 06
	AIRS CO	FY04						
	Aura: BC	FY05						
	Aerosols	FY05						
	Land-Air	FY04	>					Report FY06
	Land Charact.	FY04	>					
	Physic.	FY05						
	Future products	FY06						
AQ Fore-casting	Aerosols	FY04	>					Transition 05; others to do
	Ozone	FY05						
	others	FY06						
Emissions	WRAP							
	BlueSkyRAINS							Interagency test in FY05
	Other							
Eval. and beyond	REASoN							
	EOS							
	RSP: Emis. Inv.							
Confer-ences	EPA AQ Conf.	Feb.						
	AWMA	June						
	others							
Air Quality-related Missions (shown through planned end of life)	EP-TOMS	1992	>					
	Terra	1999	>					
	Aqua	1999	>					
	Aura	1999	>					
	GOES N-P	2005						
	CALIPSO	2005						
	CloudSat	2005						
	NPP	2006						
	OCO	2007						
	Glory	2008						
	Aquarius	2008						
	LDCM	2009						
	HYDROS	2010						
	GPM	2010						

VIII. Performance Measures

The Air Quality Management team uses performance measures to track progress, identify issues, evaluate projects, make adjustments, and establish results of the program element. The program's goal and objectives (Section II) state what the program intends to achieve. These measures help the team monitor progress within and across specific activities to ensure the program meets its goal and objectives.[1] The management team analyzes these measures retrospectively in order to made adjustments proscriptively to the program approach and objectives.

The measures are in two categories: Program Management measures are internally focused to assess the activities within the program. Performance measures are externally focused to assess if the program activities are serving their intended purpose. In general, the Air Quality program element uses these measures to evaluate the performance of activities conducted and sponsored by the program, especially the projects. In addition, the Applied Sciences Program uses this information in preparing IBPD directions and PART responses.

Program Management Measures (Internally-focused):

Inputs	Potential issues and DSTs identified for Air Quality – *number, type, range* Eligible partners to collaborate with – *number, type, range* Potential results/products identified to serve Air Quality – *number, type, range*
Outputs	Assessments or evaluations of DSTs – *number, range* Assessments of Earth science results/products to serve DSTs – *number, range* Agreements with partners – *presence* Reports (evaluation, validation, benchmark) – *number, type*
Quality & Efficiency	Earth science results/products – *number used per DST, ratio of utilized to potential* Agreements – *ratio of agreements to committed partners* Reports – *partner satisfaction, timeliness, time to develop* Reports – *ratio of validations to potential products, ratio of benchmarks to validations*

Performance & Results Measures (Externally-focused):

Outcomes	Earth science products adopted in DSTs – *number, type, range; use in DST over time* Earth science products in use – *ratio of products used by partners to reports produced* Partner & DST performance – *change in partner DST performance, number and type of public recognition of use and value of Earth science data in DST*
Impacts	Partner value – *change in partner metrics (improvements in value of partner decisions)*

In addition to the stated measures, the Air Quality program periodically requests an assessment of its plans, goals, priorities, and activities through external review. The Air Quality team uses these measures

[1] These measures are like gauges in an automobile - they serve as indicators to help the management team track conditions and identify issues in order to keep the program aligned with the plan and meet its objectives.

along with comparisons to programmatic benchmarks to support assessments of the Applied Sciences Program (e.g. internal NASA reviews and OMB PART). In specific, the Air Quality program uses comparisons to similar activities in the following programs (i.e., program benchmarks) to evaluate its progress and achievements:

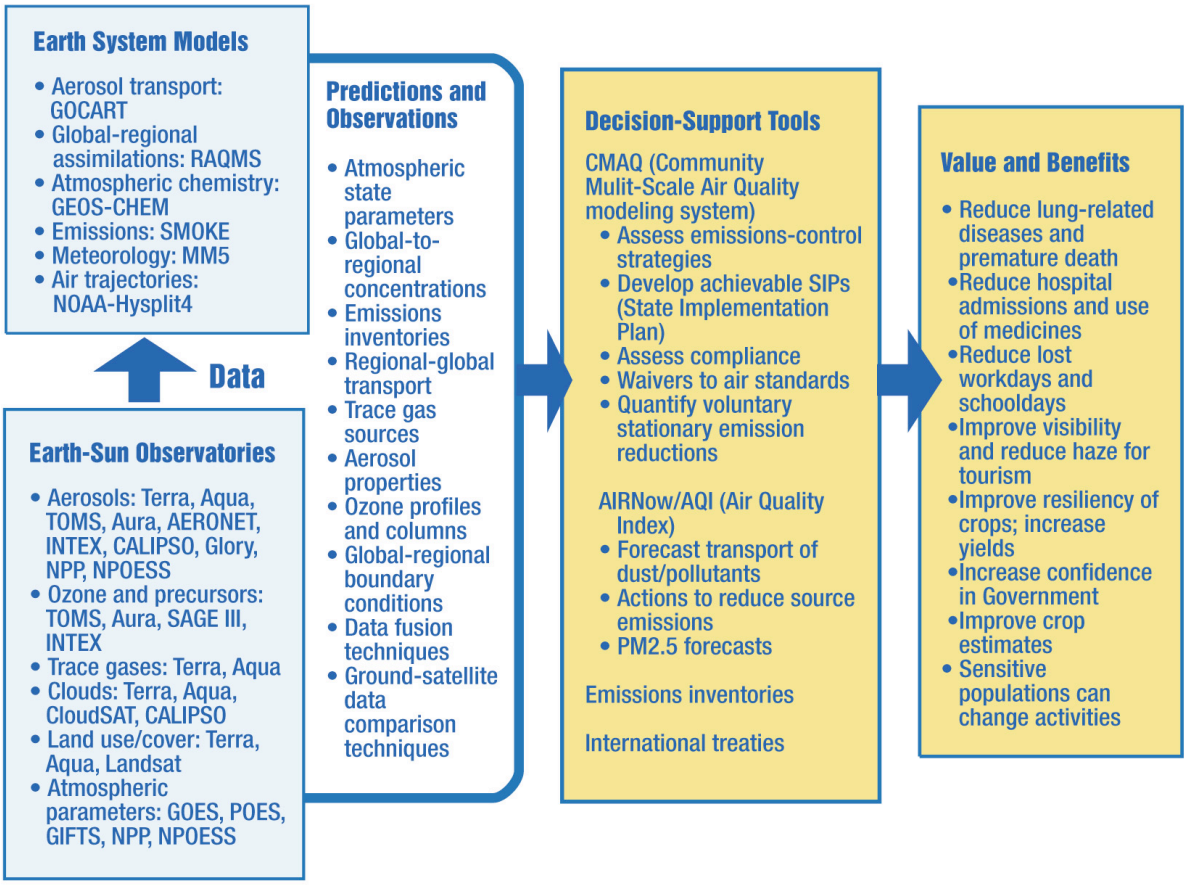
- Environmental and Societal Impacts Group at NCAR
- NCAR Research to Applications Group
- Global Monitoring for Environment and Security (GMES) in Europe

The Air Quality program will report on its progress through various programmatic media (e.g., NASA websites, AIWG website, and Earth-Sun System Gateway) and will publish articles in journals and trade media.

IX. APPENDICES

A. Integrated System Solution Diagram

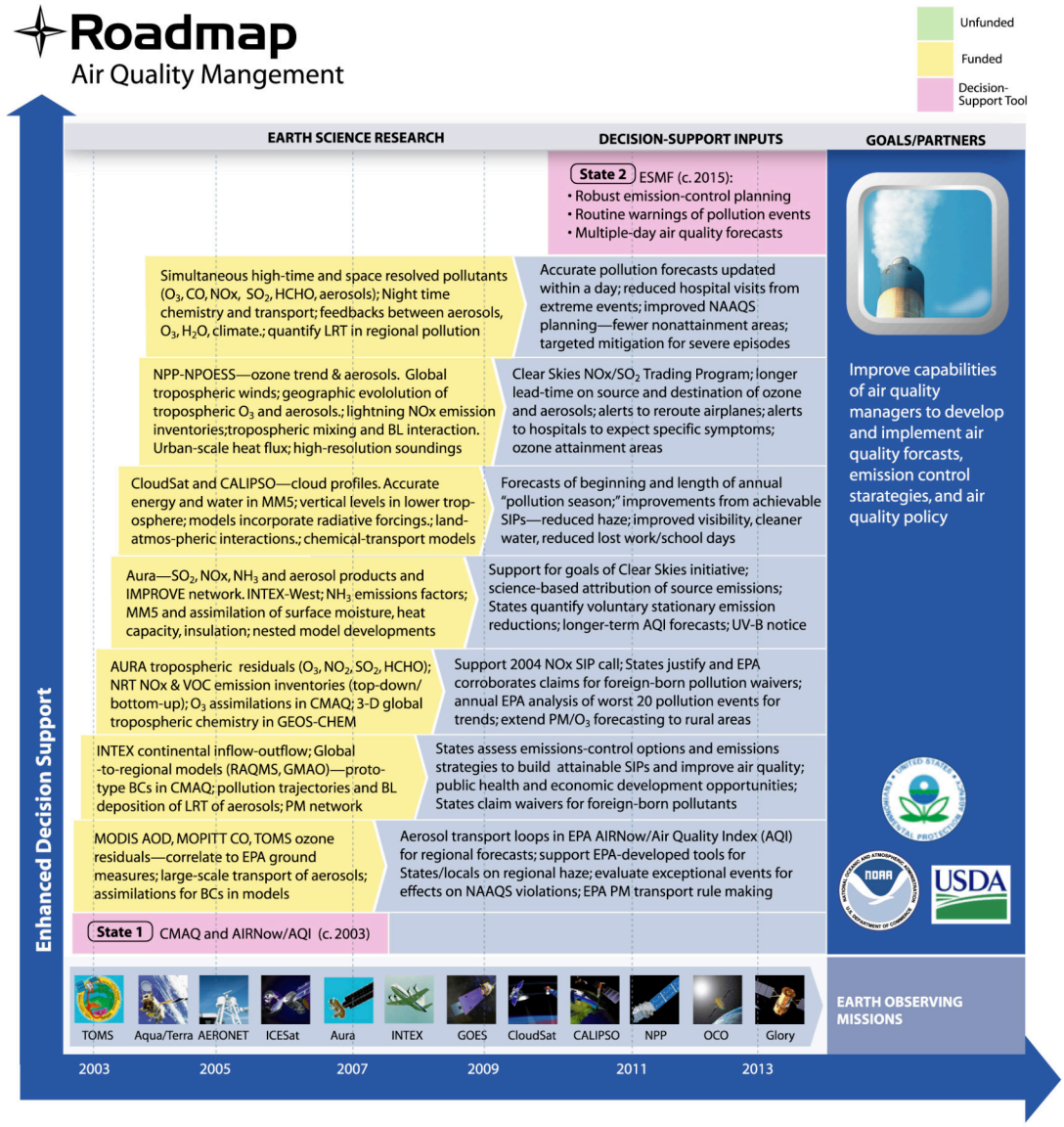
Appendix A illustrates a candidate configuration for the extension of NASA science measurements, model products, and data fusion techniques to support Air Quality partners, their decision support tools, and benefits of Earth science to society. Results from NASA Earth-Sun system science are typically observations, data sets, climate data records, algorithms, and models utilizing the observations. Observations for Air Quality Management include measures of aerosols, ozone, trace gases, cloud properties, meteorology, and land-cover/use. Models use these and other measurements to generate predictions of atmospheric and air quality conditions (e.g., aerosol transport, emissions sources, ozone levels) and to assimilate data from global-to-regional scales. The Air Quality program works with partners on methods for their decision support tools – AIRNow, CMAQ, WRF – to ingest NASA science observations and predictions and, in turn, improve the capabilities of their tools to serve their decision processes and, ultimately, the public.



B. Roadmap

The figure illustrates the evolving, progressive nature of links between the increasing capabilities of NASA-supported research, measurement systems, and technology and their extension to partners' management and policy responsibilities. The yellow bars on the left state the expected research and developments from Earth-Sun system science and technology; the blue bars to the right reflect the contributions of the research in terms of improved management capabilities. Each level shows a steady improvement in the measurements and research along with enhanced management capabilities and public value.[2]

This Air Quality application roadmap builds on the roadmaps of the six Applied Sciences Science Focus Areas, particularly the Atmospheric Composition Theme, Weather Theme, and Climate Variability and Change Theme.



[2] Note: The transition points from yellow bars to blue bars do not necessarily match the time references at the bottom of the chart due to formatting constraints.

C. Applied Sciences Program Budget FY2005

The overall program budget allocations are given below to provide the context in which this National Application is conducted. The allocations are based on Agency and program priorities and are subject to change according to the availability of funds and programmatic strategies. All values are in $ thousands.

*Note: Allocations include full utilization of the Applied Sciences FY04 carryover of approximately $2.7 million.

Table 1: Applied Sciences Procurement Allocation – FY05

Program Element	FY05 Procurement Allocation
National Applications	
Agricultural Efficiency	$ 467
Air Quality Management	$ 995
Aviation	$ 750
Carbon Management	$ 653
Coastal Management	$ 550
Disaster Management	$ 545
SENH	$ 1,429
Ecological Forecasting	$ 610
Energy Management	$ 775
Homeland Security	$ 205
Invasive Species	$ 205
Public Health	$ 725
Water Management	$ 870
Program Director Discretionary Fund	$ 588
Center Director Discretionary Fund Tax	$ 2,485
National Applications Total	$ 11,852
Crosscutting Solutions	
Integrated Benchmarked Systems	$ 3,529
Solutions Networks	$ 1,200
Competitive Solicitations	$ 7,600
Human Capital Development	$ 700
Geoscience Standards & Interoperability	$ 2,000
Crosscutting Solutions Total	$ 15,029
Applied Sciences Program Procurement Total	***$ 26,881***

Table 3: Applied Sciences Program NASA Institutional Allocations – FY05

NASA Center	FY05 Institutional Cost / National Applications	FY05 Institutional Cost / Crosscutting Solutions	Institutional Total
HQ	$3,773	$7,351	$11,124
ARC	$1,108		$1,108
GSFC	$1,009	$1,094	$2,103
JPL			
LaRC	$1,517	$444	$1,961
MSFC	$1,251	$183	$1,434
SSC	$3,194	$8,689	$11,883
Total	***$11,852***	***$17,761***	***$29,613***

D. Related NASA and Partner Solicitations

Research Projects

IDS NRA: Air Quality-related research projects

Institution	PI	Title/Subject	Timeframe
MIT	Prinn	Testing Trace-Gas Flux Models Using In Situ and Remotely Sensed Data	2003-2006

REASoN: Air Quality-related research projects

Institution	PI	Title/Subject	Timeframe
LaRC	Delnore	Synergistic Data Support of Atmospheric Chemistry Field Campaigns	2003-2006
GSFC	Holben	BAMGOMAS-Back Trajectories, Aeronet, Micropulse Lidar, GOCART, and MODIS for Aerosol Synergism	2003-2006
GISS	Rossow	Variability of Global Cloud Property Distributions from Diurnal to Decadal Time Scales	2003-2006

NPOESS Preparatory Project: Air Quality-related research projects

Institution	PI	Title/Subject	Timeframe
LaRC	Baum	Science Support for NPP Cloud Retrieval Effort	2004-2006
U.Alabama - Huntsville	Han	Measurement Accuracies of Two VIIRS Cloud EDRs: Cloud Optical Thickness and Effective Particle Size	2004-2006
U Md - CP	Justice	Assessing the NPOESS Preparatory Project (NPP) VIIRS Fire Product as a Climate Data Record	2004-2006
USGS	Loveland	Strategy to Evaluate and Enhance the NPOESS Surface Type Environmental Data Record	2004-2006
GSFC	Lyapustin	Analysis and Validation of the Aerosol and Surface Reflectance EDRs Over Land for the VIIRS	2004-2006
GSFC	McPeters	An Evaluation of OMPS Ozone Measurements for Producing NPP Climate Data Records	2004-2006
Boston U.	Schaaf	Assessment of Aerosol, Albedo, and Surface Type Environmental Data Records (EDRs) from VIIRS	2004-2006
UMBC	Torres	Assessment of NPOESS Aerosol Algorithm Enhancement Using VIIRS and OMPS Observations	2004-2006

EOS Continuation: Aqua-Terra-ACRIM Solicitation – Air Quality-related research projects

Institution	PI	Title/Subject	Timeframe
Wisconsin-Mad.	Ackerman	Refinement and Maintenance of the MODIS Cloud Mask Algorithm on Terra and Aqua	2004-2006
UMBC	Barnett	Production and Evaluation of the AIRS Trace Gas Research Products	2004-2006
CIMSS	Baum	Regional and Global Analyses of Multilayered Clouds, Ice-Phase Clouds and Mixed-Phase Clouds Using EOS Terra and Aqua Data	2004-2006
Illinois-Urbana	Bond	Understanding the Atmospheric Transformation of Anthropogenic Aerosol: Inferences from Satellite Data and Global Aerosol Modeling	2004-2006
GSFC.	Calahan	I3RC Workshops and 3D Community Tools Applied to Assessments and Improvements of Cloud Retrievals from Terra, Aqua, and THOR Offbeam Lidar	2004-2006
GSFC	Chin	A Global Model Analysis of Anthropogenic Aerosol Radiative Forcing Using Data from Terra and Aqua Satellites, Ground-Based Networks, and In-Situ Measurements	2004-2006
U.Alabama – Huntsville	Christopher	A Multi-Sensor Approach for Estimating Global Aerosol Radiative Forcing from Terra and Aqua	2004-2006
Oregon State	Coakley	Effects of Partial Cloud Cover on the Retrieval of Cloud Properties and Radiative Fluxes	2004-2006
GSFC	Descloitres	The MODIS Rapid Response System: A Model for Generating Near Real-Time Applications Products	2004-2006
GSFC	Dubovik	Enhanced Remote Sensing of Atmospheric Aerosol by Multi-Sensor AERONET/MISR/MODIS Retrieval	2004-2006
NCAR	Emmons	Closing the Carbon Monoxide Budget: Variability in CO Emissions	2004-2006
LaRC	Ferrare	Aerosol Fine and Coarse Mode Profile Retrievals Using Airborne and Space-Based Lidar and MODIS Measurements	2004-2006
UCSB	Gautier-Downes	Properties and Diurnal Radiative Forcing of Mineral Aerosols Over Deserts Using Combined AIRS and MODIS and Ground-Based Observations	2004-2006
GSFC	Hsu	Retrieving Aerosol Properties over Bright-Reflecting Surfaces: An Extension of Current MOD04/MYD04 Products	2004-2006
U.Texas-CSR	Hutchinson	Toward the Development of Advanced Data Products from EOS Terra and Aqua Direct Broadcasts for Air Quality Management in the State of Texas	2004-2006
Harvard	Jacob	Quantifying the Sources and Global Transport of Combustion Gases and Aerosols Using MOPITT, MODIS, MISR, and Related Satellite Observations	2004-2006
Stanford	Jacobson	Using Satellite Data and Models to Study the Effects of Global Climate on Regional Pollution and Vice-Versa	2004-2006
UMd – CP	Justice	Refinement and Maintenance of the MODIS Fire Product Suite and MODIS Land Discipline Leader	2004-2006
UMd – CP	Kalnay	Data Assimilation Using Advanced Infrared Sounder Data	2004-2006
GISS	Lacis	Aerosol Climatology for GCM Applications Using MODIS, MISR, and POLDER Data	2004-2006
Utah	Mace	Algorithm Refinement and Validation of Cloud and Radiation Products Derived from MODIS and CERES Radiances Using Ground-Based and Aircraft Data	2004-2006
PNNL	Marchand	Retrieval of Ice Cloud Crystal Habit and Cloud Phase Using MISR and MODIS Measurements	2004-2006

UMBC	McMillan	AIRS Trace Gas Retrieval Validation and Analysis and Fire Detection	2004-2006
Wisconsin-Mad.	Menzel	Maintaining and Refining the Calibration of Infrared Radiances and the Derivation of Cloud Properties with MODIS	2004-2006
GSFC	Platnick	Global Analysis of MODIS Level-3 Cloud Properties and Their Sensitivity to Aggregation Strategies	2004-2006
NCAR	Randel	EOS Integrated Investigations of Upper Tropospheric Water, Clouds and Temperature	2004-2006
JPL	Realmuto	Monitoring Volcanic Plumes and Clouds from Terra and Aqua	2004-2006
GSFC	Remer	Maintenance and Refinement of the Global MODIS Aerosol Products from Terra and Aqua (MOD04/MYD04)	2004-2006
MIT	Rosenkranz	AIRS/AMSU/HSB Algorithm Refinement Through Improved Cloud Liquid Water Profile Estimates and Cloud Clearing Metrics	2004-2006
Boston U.	Schaaf	Algorithm Refinement for the MODIS Bi-Directional Reflectance/Albedo Product	2004-2006
MIT	Staelin	Retrievals and Global Studies of Precipitation Rate and Cloud-Base Pressure and Temperature	2004-2006
GSFC	Susskind	Upgrade and Maintenance of the AIRS Team Level 2 Algorithm	2004-2006
GSFC.	Vermote	Fires as a Disturbance in the Earth-Atmosphere System, a Pilot Study Using MODIS Data and Experimental Algorithms	2004-2006
GSFC	Weaver	Spectral Signatures of Aerosols from Satellite Radiances	2004-2006

Fellowships

Funded under Earth-Sun Division Education – Fellowship Program

Institution	PI	Title/Subject	Award Years
CIT	Andrew Mollner	Laboratory Studies of Tropospheric Ozone Chemistry: Isoprenes	2004 award (05-07)
Texas A&M	Fan Jiwen	Investigation of Urban Aerosols and Their Impact on Cloud Microphysics	2004 award (05-07)
CU-Boulder	Alison Aiken	Aerosol Morphology and Improve Quantitative Analysis of Tropospheric Aerosols in Aircraft Studies	2004 award (05-07)
CSU	Katherine Corbin	Using Satellite Observations of CO to Improve Estimates of CO2 Sources and Sinks	2004 award (05-07)
UCLA	Troy Robert	Dehydration in the Tropical Tropopause Layer: Integration of Humidity and Temperature Data from AIRS/AMSU	2004 award (05-07)
U.Alabama – Huntsville	Jun Want	The Effect of Central American Smoke Aerosols on Air Quality and Climate over the Southeastern United States	2004 award (05-07)
CU-Boulder	John Huffman	Development and Application of a Size and Chemical Composition-Resolved Aerosol Flux Measurement	2003 award (04-06)
CSU	Kristen Koehler	Laboratory Investigations of the Links Between Mineral Dust and Cloud Formation	2003 award (04-06)

UC-Irvine	John Newberg	Ozone Chemistry with Sea-Salt Particles at the Air-Particle Interface: A Surface Analysis Approach	2003 award (04-06)
CU-Boulder	Cynthia Shaw	Derivation of Ozone Photochemical Loss by Combining Satellite Data and a 3-Dimensional Chemical Transport Model	2003 award (04-06)
Boston C.	Jay Slowick	Effect of Morphology and Composition on Hygroscopicity of Soot Aerosols	2003 award (04-06)
Harvard	Colette Heald	Global Sources of CO – Integrated Observing	2002 award (03-05)
U.Md	Heather Kilcoyne	Aerosol Retrieval Algorithms and Retrieval Method Over Land	2002 award (03-05)
CU-Boulder	Karl Feierabend	Spectrocpy and Phtoreactivity of Hydrated Complexes and Relevance to Atmospheric Chemistry	2002 award (03-05)
U.Md	Honquing Liu	Novel Approach to Global Aerosols	2002 award (03-05)
UCSD	Karen Shell	Conceptual Modeling of the Climatic Role of Airborne Mineral Dust	2002 award (03-05)
Northwestern	Andrea Voges	Heterogeneous Atmospheric Chemistry Studied Using Nonlinear Optical Techniques	2002 award (03-05)
U.Md	Stefania Korontzi	The Spatial and Temporal Distribution of Biomass Burning in Southern Africa	2002 award (03-05)

New Investigators

Funded under Earth-Sun Division Education – New Investigator Program (NIP)

Institution	PI	Title/Subject	NIP Award Years
Illinois	Larry Di Girolamo	Advancement in Satellite Remote Sensing of Cloud Properties: Global Observations and 3-D Radiative Transfer Modeling	2002-2004
Ames	Laura Irachi	Integration of Laboratory and Remote Sensing Data for Determination of the Origin of Organic Material in Lower Stratospheric Aerosol Particles	2002-2004
Princeton	Denise Mauzerall	Interannual Variability in Trans-Pacific Transport of Pollution	2002-2004
UCLA	Bjorn Stevens	NIP2002: Surface Divergence and Non-Precipitating Boundary Layer Clouds: Integrating Simple Models Using Satellite Data	2002-2004
BAERI – Ames	Jens Redeman	Terra Retrievals of Aerosol Optical Depth; Feasibility of Determining the Direct Aerosol Radiative Forcing of Climate Using Future EOS Satellite Sensors	2002-2004

GLOBE

Funded under Earth-Sun Division Education – GLOBE Program

Institution	PI	Title/Subject
Drexel	Brooks, Mims	Atmosphere: Aerosols, Haze, Water Vap
U. Toledo	Czajkowski, Benko	Atmosphere: Aerosols, Haze, Water Vap
LaRC	Fishman, DeYoung, Olson, Canright, Ladd	Atmosphere: Ozone
CSU & JPL	Stephens, Pielke (Sr), Krumm, Vane, Wittmeyer	Atmosphere: Meteorological Measureme

E. Acronyms and Websites

Acronyms

A&WMA	Air & Waste Management Association
AERONET	Aerosol Robotic Network
AIRS	Airborne Infrared Sounder
AIWG	Applications Implementation Working Group
AL	Aeronomy Lab
AMSU	Advanced Microwave Sounding Unit
AOD	Aerosol Optical Depth
APS	Aerosol Polarimetric Sensor
AQI	Air Quality Index
Aqua	Spacecraft with instruments to collect information on Earth's water cycle
Aquarius	Spacecraft with instruments to map global salt concentrations on ocean surface
ARC	Ames Research Center
ARL	Air Resources Lab
ATBD	Algorithm Theoretical Basis Document
Aura	Spacecraft with instruments to study Earth's ozone, air quality, climate
BAERI	Bay Area Environmental Research Institute
BAMGOMAS	Back trajectories, AERONET, MODIS, GOCART, MPLNET, Aerosol Synergism
BlueSkyRAINS	BlueSky Rapid Access Information System
CAEP	Civil Aviation Environmental Program
CALIPSO	Cloud-Aerosol LIDAR and Infrared Pathfinder Satellite Observations
CCSP	Climate Change Science Program
CCTP	Climate Change Technology Program
CDC	Centers for Disease Control and Prevention
CENR	Committee on Environment and Natural Resources
CENRAP	Central Regional Air Planning Association
CERES	Clouds and the Earth's Radiant Energy System
CIMSS	Cooperative Institute for Meteorological Satellite Studies
CIT	California Institute of Technology
CMAQ	Community Multi-scale Air Quality model
CO	Carbon Monoxide
CO_2	Carbon Dioxide
COT	Cloud Optical Thickness
CSU	Colorado State University
CU-Boulder	Colorado University at Boulder
DAAC	Distributed Active Archive Center (Data Active Archive Center)
DEVELOP	No longer an acronym
DSS	Decision Support Systems
DST	Decision Support Tool
ECOS	Environmental Council of the States
EDR	Environmental Data Records
EOS	Earth Observing Systems
EOSDIS	Earth Observing System Data Information System
EP-TOMS	Earth Probe – Total Ozone Mapping Spectrometer
EPA	Environmental Protection Agency
EPHTN	Environmental Public Health Tracking Network

ESIP	Earth Science Information Partnership
ESG	Earth-Sun Gateway
FAA	Federal Aviation Administration
FEA	Federal Enterprise Architecture
FGDC	Federal Geographic Data Committee
FSL	Forecast Systems Laboratory
FY	Fiscal Year
GCM	Global Climate Model
GEO	ad hoc Group on Earth Observations
GEOS-CHEM	Goddard Earth Observing System-CHEMistry
GEOSS	Global Earth Observation System of Systems
GES DAAC	Goddard Earth Science Distributed Active Archive Center
GIG	Global Information Grid
GISS	Goddard Institute for Space Studies
GMAO	Global Modeling and Assimilation Office
GMES	Global Monitoring for Environment and Security
GOCART	Global Ozone Chemistry Aerosol Radiation Transport
GOES	Geostationary Operational Environmental Satellite
GOS	Geospatial One Stop
GSFC	Goddard Space Flight Center
HCHO	Formaldehyde
HRDLS	High-Resolution Dynamics Limb Sounder
HSB	Humidity Sounder for Brazil
HYDROS	Hydrosphere State Mission
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IBPD	Integrated Budget and Performance Document
ICAO	International Civil Aviation Organization
IGACO	Integrated Global Atmospheric Chemistry Observations
IGOS	Integrated Global Observations Strategy
IWGEO	Interagency Working Group on Earth Observations
JACIE	Joint Agency Commercial Imagery Evaluation
JCSDA	Joint Center for Satellite Data Assimilation
JPL	Jet Propulsion Laboratory
LaRC	Langley Research Center
LIDAR	Light Detecting and Ranging
LP DAAC	Land Processes Distributed Active Archive Center
MANE-VU	Mid-Atlantic Northeast Visibility Union
MISR	Multiple Input Shift Register
MIT	Massachusetts Institute of Technology
MM5	Mesoscale Model
MODIS	Moderate Resolution Imaging Spectroradiometer
MOPITT	Measurements Of Pollution In The Troposphere
MSFC	Marshall Space Flight Center
N/A	Not Applicable
NARSTO	North American Research Strategy for Tropospheric Ozone
NAS	National Academy of Sciences
NASA HQ	NASA Headquarters
NASA	National Aeronautics and Space Administration
NCAR	National Center for Atmospheric Research
NCEP	National Centers for Environmental Prediction
NESDIS	National Environmental Satellite Data Information Service

NIP2002	New Investigator Program 2002
NH_3	Ammonia
NO_2	Nitrogen Dioxide
NO_x	refers to the different Nitrogen Oxide atmospheric compounds
NOAA	National Oceanic and Atmospheric Administration
NPOESS	National Polar-Orbiting Operational Environmental Satellite System
NPP	NPOESS Preparatory Project
NSF	National Science Foundation
NWS	National Weather Service
OAQPS	Office of Air Quality Planning and Standards
OAR	Office of Oceanic and Atmospheric Research
OCO	Orbiting Carbon Observatory
OEI	Office of Environmental Information
OMB	Office of Management and Budget
OMI	Ozone Measuring Instrument
ORD	Office of Research and Development
OSSE	Observing System Simulation Experiment
PAM	Protected Area Management
PART	Program Assessment Rating Tool
PM	Particulate Matter
PM	Project Manager
POLDER	Polarization and Directionality of Earth's Reflectance
R2O	Research to Operations Network
RAQMS	Regional Air Quality Modeling system
REASoN	Research, Education, and Applications Solutions Network
RPO	Regional Planning Organization
SEA	State Enterprise Architecture
SO_2	Sulfur Dioxide
SSC	Stennis Space Center
TBD	To Be Determined
Terra	Spacecraft with instruments measuring Earth’s climate
TES	Thermal Emission Spectrometer
THOR	Thickness from Offbeam Returns
TOMS	Total Ozone Mapping Spectrometer
UC – Irvine	University of California at Irvine
UCLA	University of California Los Angeles
UCSD	University of California San Diego
U Md – CP	University of Maryland at College Park
UMBC	University of Maryland Baltimore County
USDA	US Department of Agriculture
USFS	US forest Service
V&V	Verification & Validation
VIIRS	Visible/Infrared Imager/Radiometer Suite
VIRS	Visible Infrared Scanner
VISTA	Visibility Improvement State and Tribal Association of Southeast
VOC	Volatile Organic Compound
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecast
WRF-CHEM	Weather Research Forecast – Chemistry

Websites

AIWG: http://aiwg.gsfc.nasa.gov/

Applied Sciences Program: http://science.hq.nasa.gov/earth-sun/applications

DEVELOP: http://develop.larc.nasa.gov

Earth-Sun System Gateway (ESG): http://esg.gsfc.nasa.gov/

Earth-Sun Science System Components: http://www.asd.ssc.nasa.gov/m2m

NASA FY2005 Budget: http://www.ifmp.nasa.gov/codeb/budget2005

Research and Analysis Program: http://science.hq.nasa.gov/earth-sun/science/

Science Mission Directorate: http://science.hq.nasa.gov

Science Strategies: http://science.hq.nasa.gov/strategy/